

Electric Drive Technology Market Trends

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Clean Cities Strategic Activities Led to PEV Success

– Technical Assistance

- **Technology Bulletins and Reports**
 - Posting of 16 PEV Readiness Grant reports
 - Completion of a Guide to PEV Readiness Grant findings
- **Clean Cities University**
 - Course: Electric Drive Vehicles: Overview and Impacts
- **Training**
 - EVSE Residential Charging Installation
 - First Responders

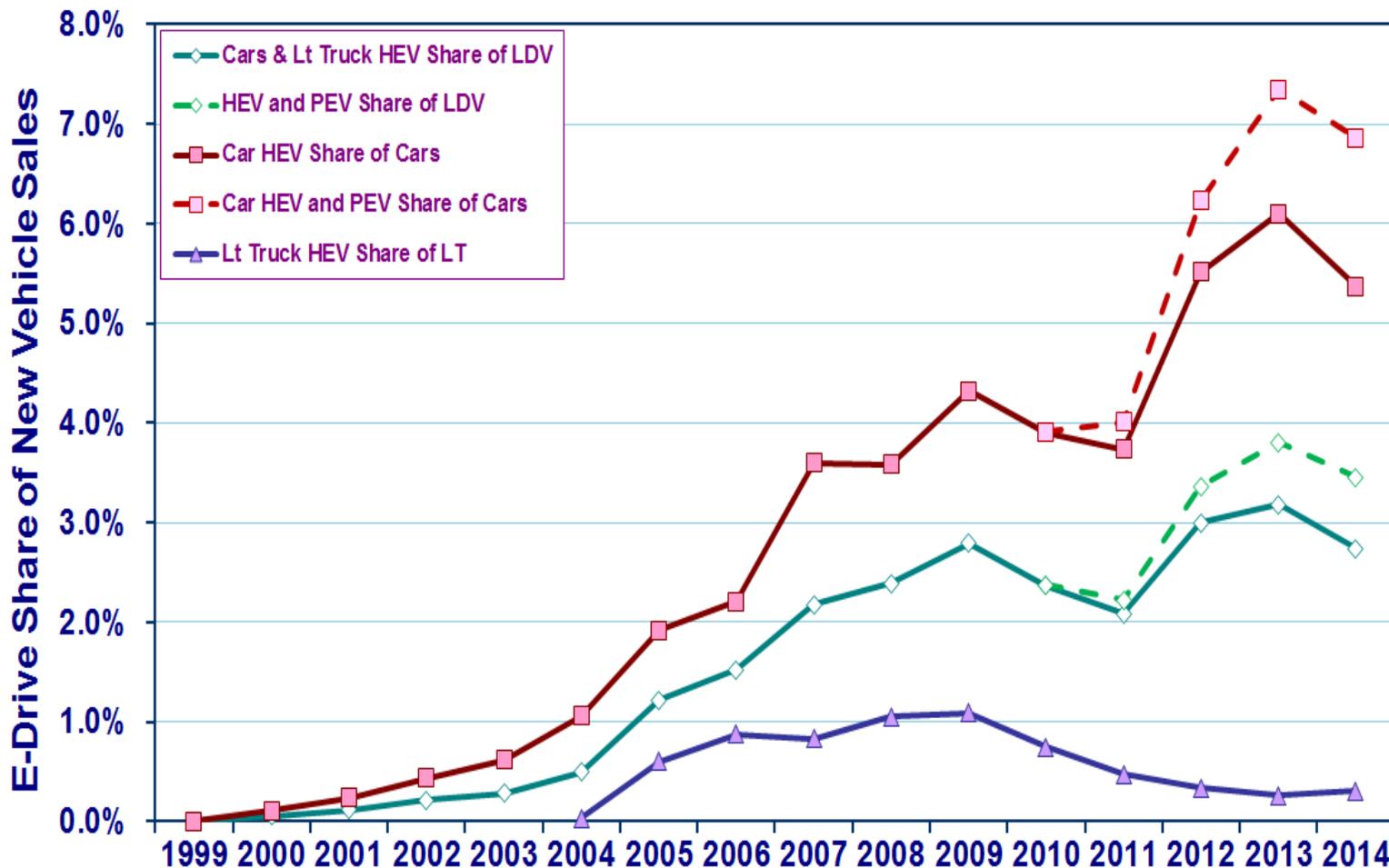
– Tools

- **ANL AFLEET**
 - Life Cycle Emissions & Economic Evaluation for Fleets
- **NREL AFDC tools**
 - Station locator, PREP (oil & GHG reduction), PEV Readiness Guide, Permit Template
- **fueleconomy.gov**
 - Annual cost calculator, My Plug-in Hybrid Calculator, GHG calculator, Emissions rating

Clean Cities Strategic Activities Led to PEV Success

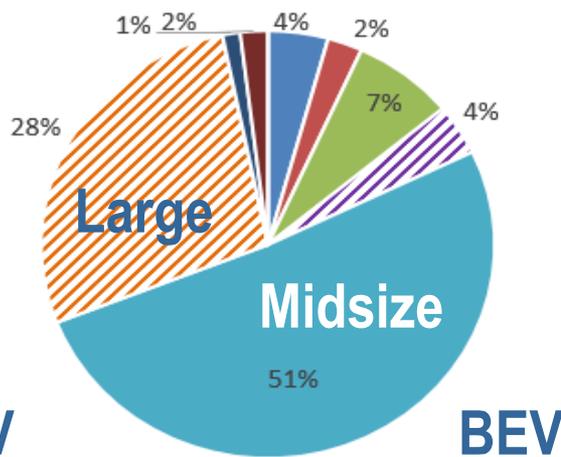
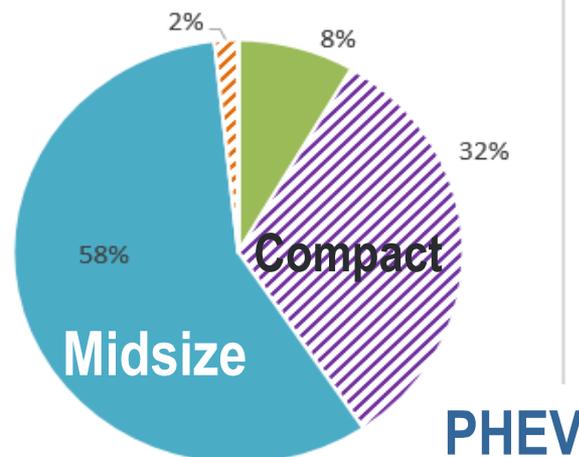
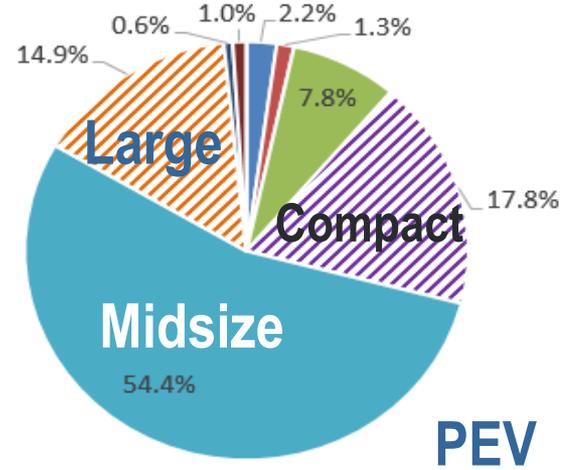
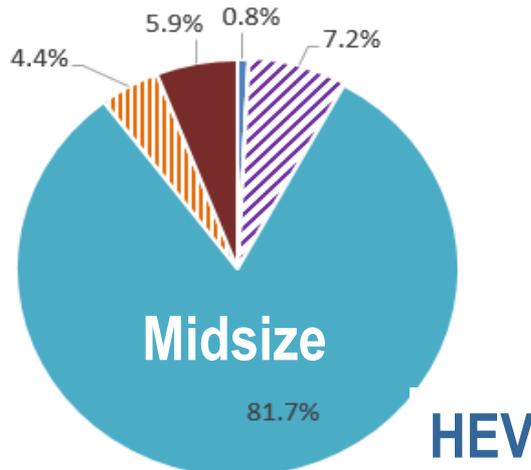
- **Communication Products**
 - **AFDC and Clean Cities Websites**
 - Vehicle Cost Calculator, Alternative Fuel and Advance Vehicle Search, and Laws and Incentives Database
 - **Handbooks**
 - Workplace Charging Hosts, Fleet Managers, Electrical Contractors, Consumers, Public Charging Hosts, Multi-Unit Dwellings
 - **Quarterly PEV Webinars**
- **Partnerships**
 - **National Clean Fleets Partnership.**
 - Frito Lay BEVs on dense urban routes
 - **National Parks Initiative.**
 - Shenandoah uses BEVs
 - **Workplace Charging Challenge**
 - Coordinators promote program participation, host informational meetings
 - **National Governors Association**
 - PEV policy and technology workshops (2)

Electric Drive was started by HEVs in 1999. Cars succeeded, trucks did not.

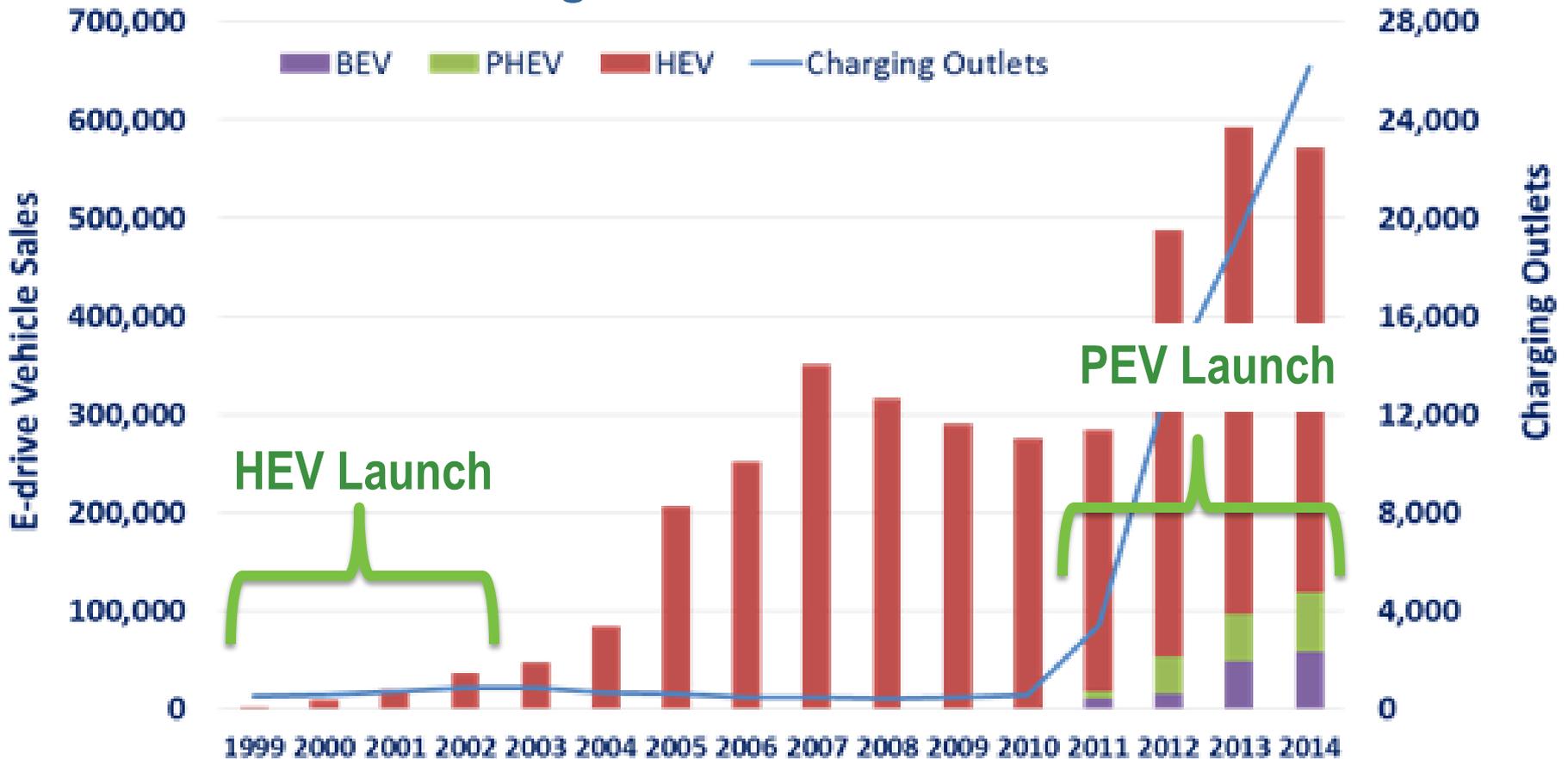


Plug-in electric vehicles (PEVs) are also cars. Plug-in hybrids (PHEVs) sold are smaller than HEVs. Battery electric vehicles (BEVs) are bigger.

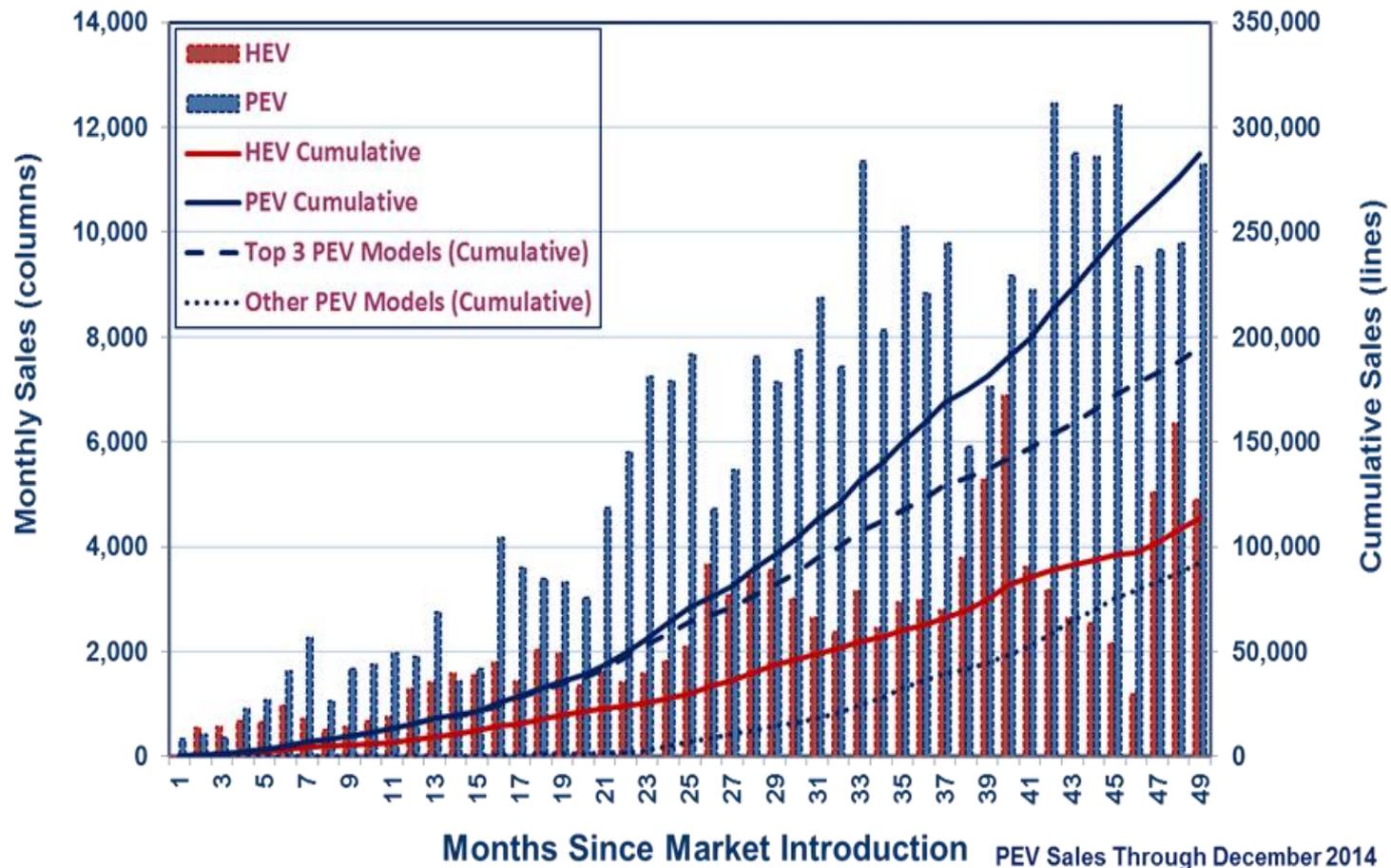
- two seaters
- minicompact
- subcompact
- compact
- midsize
- large
- station wagon
- SUV
- Pickup



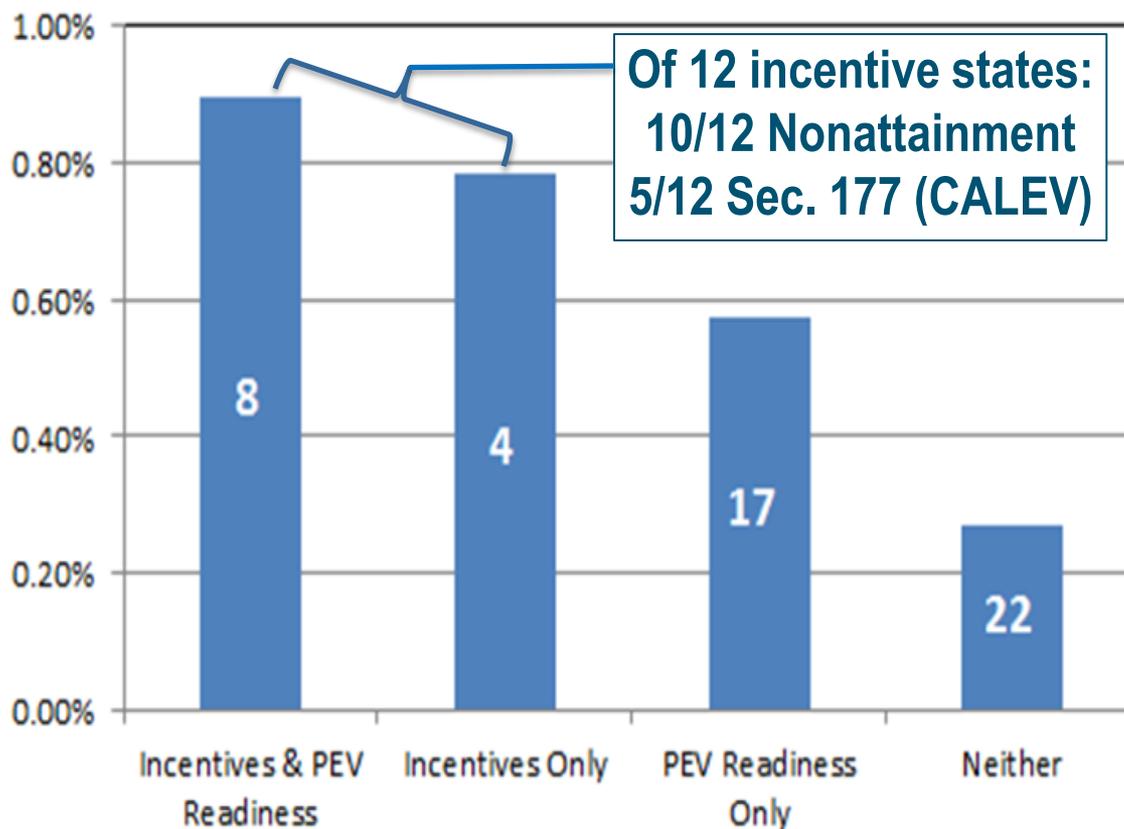
Recent take-off of PEVs was also supported by CC ARRA Grants resulting in 855 Stations and 330 PEVs.



Incentives, planning, coordination, diverse models, and higher oil prices made initial PEV sales rise faster than initial HEV sales.



Incentives, planning and coordination clearly helped states expand PEV shares



Average PEV shares by group, with number of states in group

Consumer & coordinator conundrum – what PEV to buy, what PEV to promote? Complexity is also a challenge for dealers.

Classification of Hybrid Vehicles

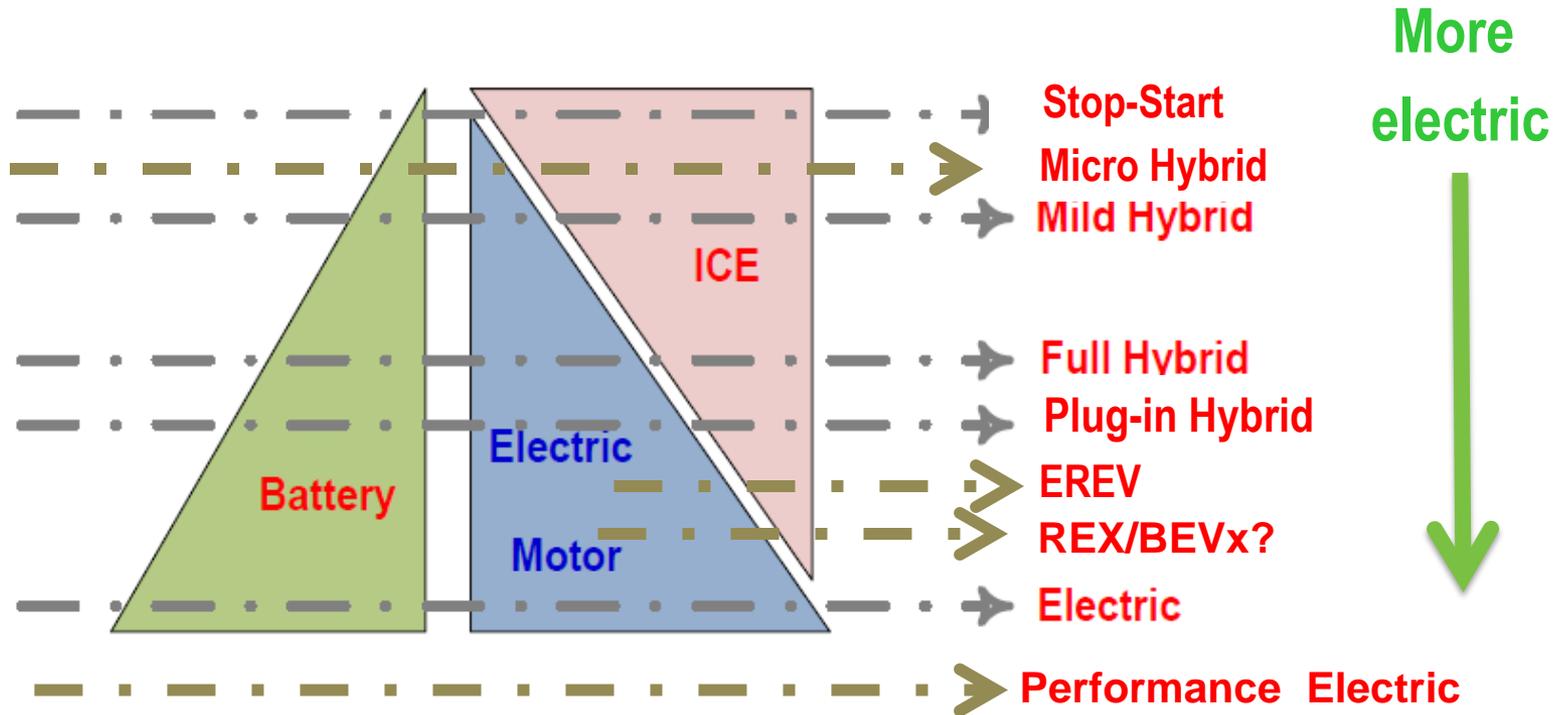
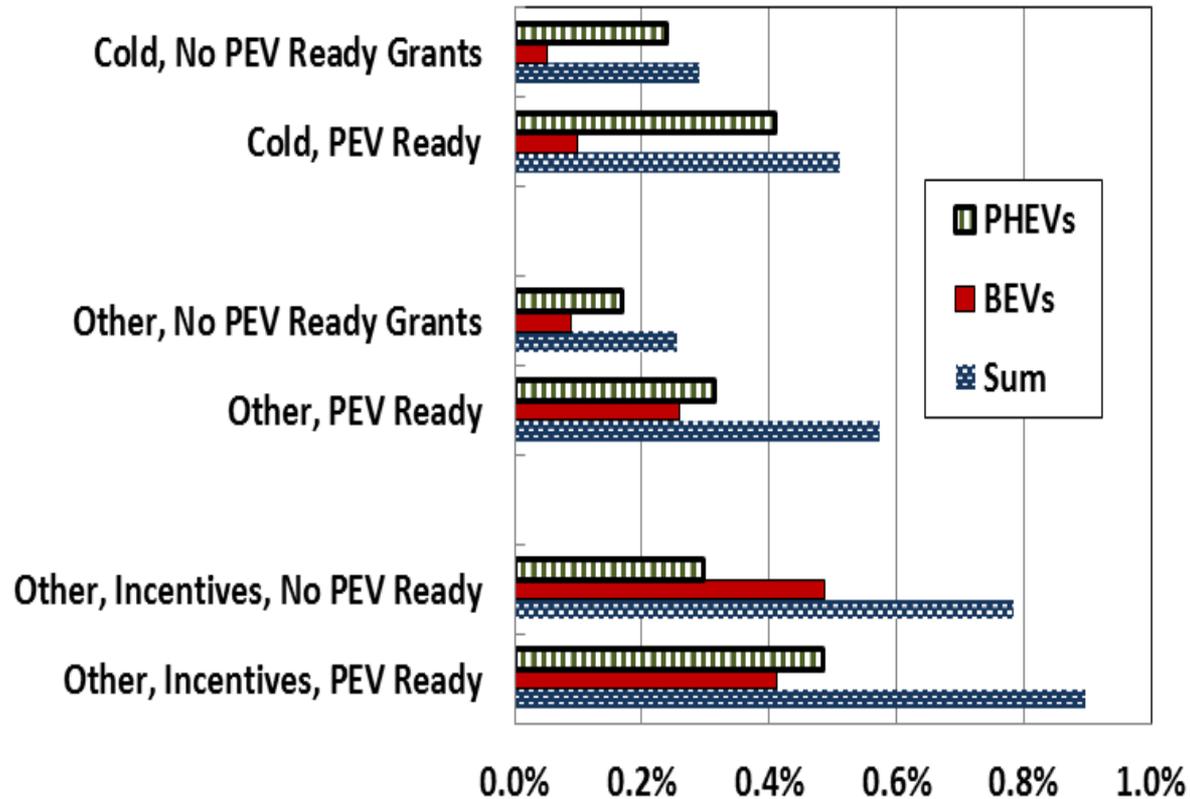


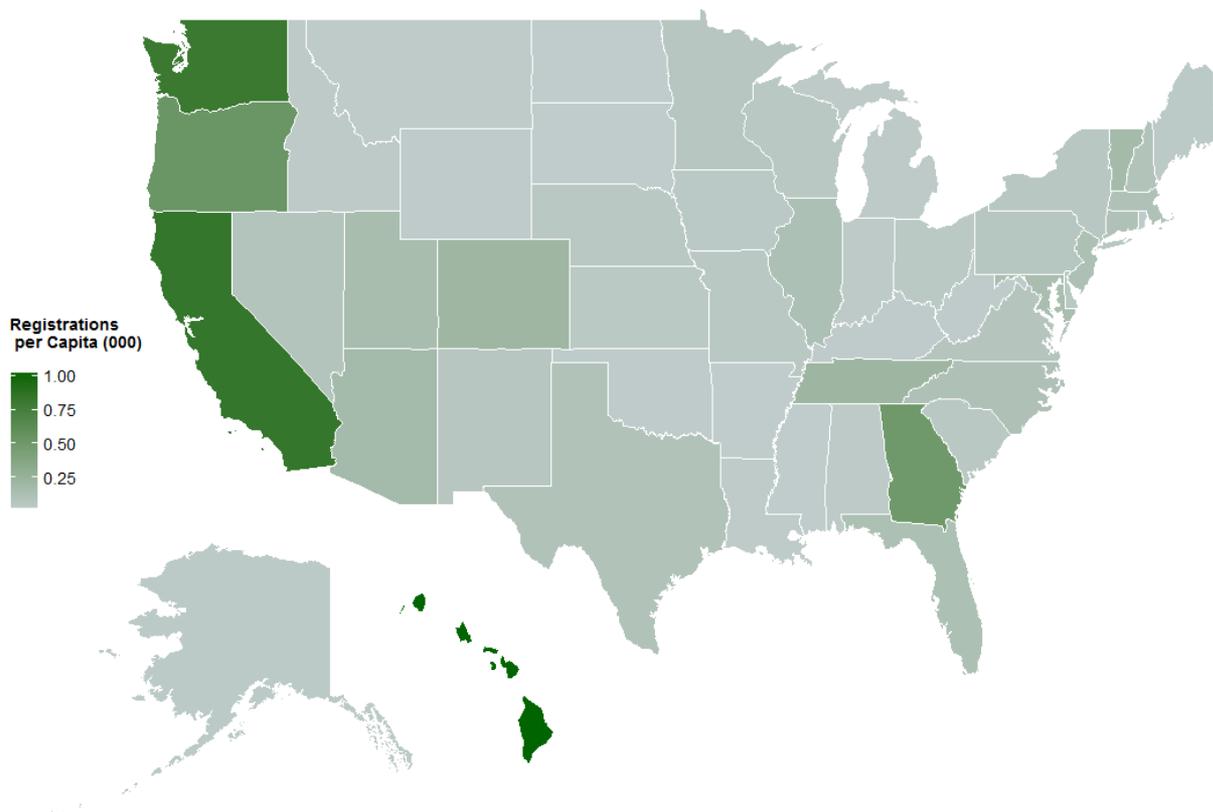
Figure: Classification of hybrid vehicle based on degree of hybridization

Cold climate (BEV range penalty) reduced BEV shares while incentives (mostly states in air quality nonattainment) helped



Average PEV shares by group

For BEVs, the Pacific coast leads; moderate coastal climate helps reduce both summer & winter BEV range penalties



Battery electric vehicles per capita (thanks NREL)

| Niche | Defining Characteristic |
|---|---|
| HEV passenger cars nationwide | 5-30% mpg improvement, usually better in city driving |
| Dense urban, high use rate (hours/day and days/yr.) | 30% (HEVs/PHEVs) to 100%(BEVs) oil use reduction with low top speed, many stops |
| Workplace charging nationwide | Up to 1.5 annual electric range multiplier for PHEVs that mostly deplete by work arrival |
| Cold climate areas | Gasoline engines to evade 40-50% BEV cold day range reduction & heating inadequacy |
| New metro edge construction | Low infrastructure cost planned ahead, long day's driving saving a lot per day |
| Nonattainment areas | All-electric operation all day (BEVs), or at least into early afternoon (EREV, BEVx) |

Niche markets are best served by focus on particular types of plug-in and HEV powertrains

| Niche | Electric Drive Types | Relative size of market |
|---|--|-------------------------|
| HEV passenger cars nationwide | Micro, Mild and Full HEVs | Large |
| Dense urban, high use rate (hours/day and days/yr.) | BEV cars. Trucks, buses: any Plug-in , any HEV | Small |
| Workplace charging nationwide | PHEVs and some EREVs | Large |
| Cold climate areas | PHEV, EREV, BEVx | Intermediate |
| New metro edge construction | PHEV, EREV, BEVx, Performance BEV | Small |
| Nonattainment areas | BEV, Performance BEV possibly EREV & BEVx | Intermediate |

Suggested DOE R&D & Clean Cities Strategies Advancing Niche Success



| Niche | Technology, market and/or policy to accelerate adoption (Santini post-paper judgments) |
|-----------------------------|---|
| HEV passenger cars | <p>Market - focus on cars and small crossovers, not trucks Technology – higher power for small battery packs Policy – promote plug-in ready full HEVs (pack/plug retrofit)</p> |
| Dense urban electric drive | <p>Implement moderately high kW, fast EVSE at workplaces, and other intra-metro public spaces, for both trucks & BEVs</p> |
| Workplace charging | <p>Tech. safe, reliable ~ 2 kW EVSE w J1772 “nozzles” on reels. Policy - no afternoon summer charges; avoids demand charge. Market – high L1 EVSE % rural/suburb, high L2 dense urban</p> |
| Cold climate | <p>Tech. OEMs choose best BEVx engine for heat & power Policy – one code for outdoor engine heating and PEV plugs</p> |
| New metro edge construction | <p>Market – high daily miles, high commute, new low density Policy – building codes for pre-installation of EVSE circuits Pre-installation at workplaces, MUDs and other high use spots</p> |
| Nonattainment areas | <p>Policy & Technology – If PHEVs to be allowed: requirement that PHEVs with >30 mi range <u>must</u> deplete all-electrically when low emissions are required and must leave house with full charge</p> |

- **Partnerships:**
 - Develop/enhance multi-state institutions to support large cohesive markets for suitable PEV types. Solicit OEM competition & cooperation in refining and marketing those PEVs (nonattainment, cold climate).
- **Local coalitions:**
 - Dense urban — indentify/cater to fleet and fleet-like customers (high hours/day & days/yr. of vehicle use from fixed overnight locations)
 - New metro edge construction — implement local building codes promoting pre-installation of appropriate EVSE circuits
 - Workplace charging — partner with local utilities, state energy offices, employers & employees to develop & codify good workday charging strategies, matching EVSE technology to needs
 - HEV (& PEV) passenger cars — work with dealerships and educational institutions to teach reasons that particular types are good or bad choices for individual consumer driving patterns

- Electric drive is a complex, multi-faceted portfolio of specialized technologies best fitting into niches.
- Four technology/niche pairings are intra-metro local
- “Two” are regional
 - Nonattainment states(26 + DC) /LDV CALEV(14) /ZEV Action Plan (8)
 - Cold climate states
- National activities need to match correct technologies & customers for best fuel, air quality & GHG results.
- Coordinators need to know & nurture correct technologies and applications for their area to develop barrier-busting state & metro standards, codes, incentives & regulations.

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